DE

Engine Functional Design

* Selection of engine type, stroke & Bore, No. of cylinders, cylinder arrangement.

∴ Internal combustion engines are usually classified on the basis of thermodynamic cycle of operation, type of fuel used, method of charging the cylinder, type of ignition, type of cooling & the cylinder arrangement etc.

→ ① Cycle of operation:

i) Constant volume heat addition cycle engine / Otto cycle engine. It is also called a spark ignition engine, SI engine or gasoline engine.

ii) Constant pressure heat addition cycle engine / Diesel cycle engine. It is also called a compression ignition engine. CI engine or Diesel engine.

→ ② Type of fuel used:

i) Engines using volatile liquid fuels like gasoline, alcohol, kerosene, benzene etc. - fuel mixed with air to form homogeneous charge in carburettor outside the cylinder & drawn into cylinder in its suction stroke. The charge is ignited near the end of compression stroke by an externally applied spark. Hence called SI engine.

ii) Engines using gaseous fuels like natural gas (LPG) blast furnace gas & biogas. It is also one type of SI engine.

iii) Engine using solid fuels like charcoal, powdered coal etc. Solid fuels are generally converted into gaseous fuels outside the engine in a separate gas producer & engine works as a gas engine.

iv) Engines using viscous liquid fuels like heavy & light diesel oils. Fuel introduced into cylinder in to the form of minute droplets by a fuel injection system near the end of compression process. The combustion of fuel takes place due to high temperature air (compressed) → CI engine

v) Engines using two fuels; A gaseous fuel or a highly volatile liquid fuel is supplied along the air during the suction stroke & other fuel is injected into the combustion space near the end of the compression stroke. (dual-fuel engines)

→ (3) Method of charging

i) Naturally aspirated engines - Admission of air / fuel-air mixture at near atmospheric pressure.

ii) Supercharged engines - Admission of air / fuel air mixture under pressure i.e above atm. pressure.

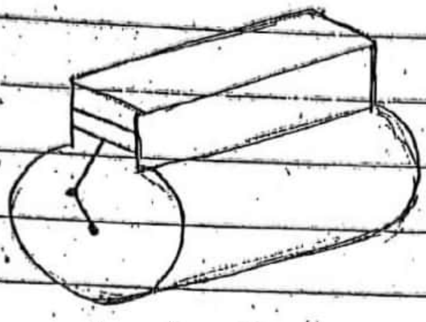
→ (4) Type of Ignition

SI engines require an external source of energy ... [illegible] of spark ...

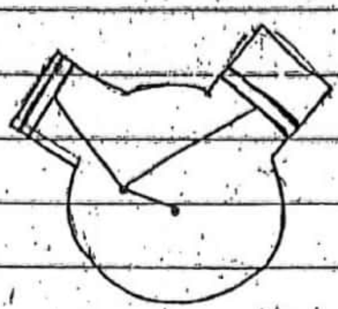
They derive their name based on whether a battery or a magneto is used as the primary source of energy for producing spark.
In the case of CI engines there is no need for an external means to produce the ignition. Because of high compression ratio employed, the resulting temperature at the end of the compression process is high enough to self ignite the fuel when injected.

→ (5) Type of cooling
Cooling is very essential for the satisfactory running of the engine.
i) Air cooled engine
ii) Water cooled engine

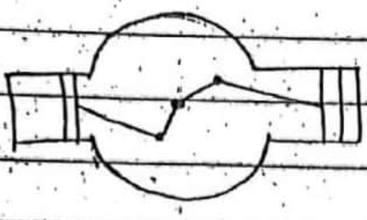
→ (6) Cylinder arrangements
Applicable to multicylinder engines only.
i) In line engine → All cylinders are arranged linearly & transmit power to a single crankshaft
ii) 'V' engine → Two banks of cylinders inclined at an angle to each other & with one crankshaft.
iii) Opposed cylinder engine → Two cylinder banks located in the same plane on opposite sides of the crankshaft.
iv) Opposed piston engine → Single cylinder houses two pistons each of which driving a separate crankshaft.
v) Radial engine → More than two cylinders in each row are equally spaced around the crankshaft. odd no of cyl. = balancing



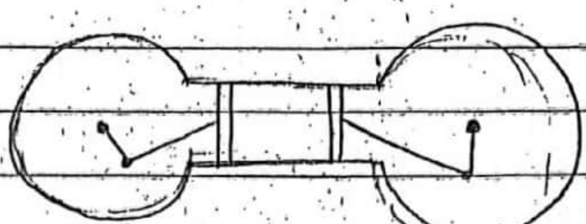
In-line



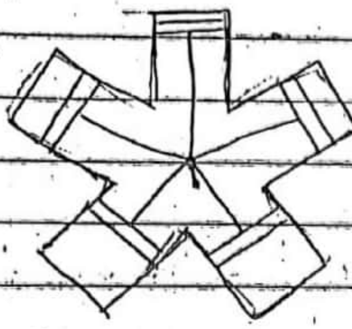
V-type



opposed cylinder.



opposed piston



Radial

→ ⑦ Number of cylinder.

i) Single cylinder engine
ii) Multicylinder engine.

Power output is more uniform in case of multi cylinder engines due to increase in frequency of power impulses with the increase in the number of cylinders.

* Effect of bore diameter.

The piston head area $A = \frac{\pi}{4} d^2$, Therefore doubling the cylinder diameter would increa[se] the piston [illegible] four times which [illegible] because [illegible] pressure. This would further mean that for a given piston speed & mean effective pressure, doubling the cylinder would increase the power four times.

* Effect of stroke

Doubling the stroke length for the same cylinder diameter would double the power, of for a given crankshaft speed the stroke is doubled the piston speed would also be doubled. Doubling the stroke doubles the crank throw. Doubling both the cylinder diameter & the piston stroke would increase the torque 8 times.

Examples

① The cubic capacity of a four-stroke over square spark-ignition engine is 245 cc. The over square ratio is 1.1. The clearance volume is 27.2 cc. Calculate the bore, stroke & compression ratio of the engine.

→ Given:

$V_s = 245$ cc

over square ratio $= 1.1$ $\quad \frac{d}{L} = 1.1$

$V_c = 27.2$ cc

Solution:

$$V_s = \frac{\pi}{4} d^2 L$$

$$245 = \frac{\pi}{4} d^2 \times \frac{d}{1.1}$$

$$245 = \frac{\pi}{4} \frac{d^3}{1.1}$$

$d^3 = 343$

Bore, $\boxed{d = 7\ cm}$

Stroke, $L = \frac{d}{\text{over square ratio}}$

$L = \frac{7}{1.1}$

$\boxed{L = 6.36\ cm}$

compression ratio, $r = \frac{V_s + V_c}{V_c}$

$r = \frac{245 + 27.2}{27.2}$

$\boxed{r = 10}$

Q. (2) The mechanical efficiency of a single cylinder four stroke engine is 80%. The frictional power is estimated to be 25 kW. Calculate the indicated power (ip) & brake power (bp) developed by engine.

→ Given,

$\eta_{mech} = 80\%$

$f_p = 25\ kW$

Solution

$\frac{bp}{ip} = 0.8$ $bp = 0.8\ ip$

$i.p - b.p$ ...

$$ip = \frac{25}{0.2}$$

$$\boxed{ip = 125\ kW}$$

$$bp = ip - fp$$

$$bp = 125 - 25$$

$$\boxed{bp = 100\ kW}$$

(3) A 42.5 kW engine has a mechanical efficiency of 85%. Find the indicated power & frictional power. If the frictional power is assumed to be constant with load, what will be the mechanical efficiency at 60% of the load?

→ $\eta_m = 85\% = 0.85$

$bp = 42.5\ kW$

Solution

$$\eta_m = \frac{bp}{ip}$$

$$ip = \frac{42.5}{0.85} = 50\ kW$$

$$f_p = ip - bp = 50 - 42.5$$

$$\boxed{fp = 7.5\ kW}$$

Brake power at 60% load $= 42.5 \times 0.6$

$= 25.5\ kW$

Mechanical efficiency $= \frac{bp}{bp + fp} = \frac{25.5}{25.5 + 7.5}$

$\eta_m = 0.773 = 77.3\%$

(4) An one litre cubic capacity ; four stroke, four cylinder of engine has a brake thermal efficiency of 30% & indicated power is 40kW at full load. At half load, it has a mechanical losses Efficiency of 65%. Assuming const. M calculate,

i) brake power

ii) frictional power

iii) Mechanical efficiency at full load

iv) Indicated thermal efficiency

If the volume decreases by eight fold during the compression stroke, calculate the clearance volume.

→ Given,

$\eta_b = 30\% = 0.3$ } Full load
$ip = 40kW$

$\eta_m = 65\% = 0.65$ ---- half load

Solution

$bp + fp = 40kW$ ——— (1)

At half load ; bp = 0.5 × bp at full load

$$\eta_m = 0.65 = \frac{0.5bp}{0.5bp + fp}$$

$$0.5\,bp = 0.65(0.5\,bp + fp)$$

$$0.5\,bp = 0.325\,bp + 0.65\,fp$$

$$fp = 0.179\,bp$$

put eqn (5) in eqn (1)

$$bp = \frac{40}{1.27}$$

$$\boxed{bp = 81.5\ kW}$$

$$fp = 0.27 \times 81.5$$

$$\boxed{fp = 8.6\ kW}$$

$$\eta_m \text{ at full load} = \frac{bp}{ip} = \frac{31.5}{40}$$

$$\eta_m = 0.788 = 78.8\%$$

$$\eta_{ith} = \frac{\eta_{bth}}{\eta_m} = \frac{30}{78.8} \times 100$$

$$\boxed{\eta_{ith} = 38\%}$$

Swept volume / cylinder $= \frac{1000}{4} = 250\ cc$

$$r = \frac{V_s + V_c}{V_c} = 1 + \frac{V_s}{V_c} = 8$$

$$V_c = \frac{250}{7}$$

$$\boxed{V_c = 35.71\ cc}$$

(5) The indicated thermal efficiency of four stroke engine is 78%. The fuel consumption rate is 20 kg/h running at a fixed speed. The brake mean pressure developed is 6 bar & the mean piston speed is 12 m/s. Assuming it to be a single cylinder square engine, calculate the crank radius & the speed of the engine. Take CV = 42000 kJ/kg

→ Given;

$\eta_m = 78\% = 0.78$, $\eta_{ith} = 32\% = 0.32$

$f_c = 20\ kg/h$

$P_{bm} = 6\ bar = 6 \times 10^5\ N/m^2$

$\bar{S}_p = 12\ m/s$

$CV = 42000\ kJ/kg$

Solution

Brake thermal efficiency,

$$\eta_{bth} = \eta_{ith} \times \eta_m$$

$$= 0.32 \times 0.78$$

$$= 0.2496$$

$$\boxed{\eta_{bth} = 24.96\%}$$

Rate of energy input from fuel $= \frac{\text{mass of fuel}}{\text{second}} \times C.V$

$$= \frac{20}{3600} \times 42000$$

$$= 233.33\ kW$$

Brake power $= \eta_{bth} \times 233.33$

[illegible]

Since it is a square engine, d = L

$$P_{bm} = \frac{bp \times 60000}{LAnK}$$

$$6 \times 10^5 = \frac{58.24 \times 60000}{\frac{\pi}{4} L^3 \times n \times 1}$$

$$\boxed{L^3 n = 7.419} \longrightarrow (1)$$

L is in meter & N is in /min.

$$\bar{S_p} = \frac{2LN}{60}$$

$$12 = \frac{2LN}{60}$$

$$\boxed{LN = 360} \longrightarrow (2)$$

dividing (1) by (2)

$$\frac{L^2 n}{N} = 0.0206$$

For a four stroke engine $n/N = \frac{1}{2}$

$$L = \sqrt{0.0206 \times 2}$$

$$L = 0.203 \text{ m}$$

$$\boxed{L = 203 \text{ mm}}$$

$$\text{Crank radius} = \frac{203}{2} = 101.5 \text{ mm}$$

$$\text{Speed, } N = \frac{360}{L} = \frac{360}{0.203}$$

$$\boxed{N = 1773.4 \text{ rpm}}$$

Formulae

① Indicated thermal efficiency

$$\eta_{ith} = \frac{ip}{\text{energy in fuel / second}} \quad \Big/ \quad \eta_{ith} = \frac{\eta_{bth}}{\eta_m}$$

② Brake thermal efficiency

$$\eta_{bth} = \frac{bp}{\text{Mass of fuel/s} \times \text{calorific value of fuel}}$$

③ Mechanical efficiency

$$\eta_m = \frac{bp}{ip} = \frac{bp}{bp + fp}$$

$$fp = ip - bp$$

④ volumetric efficiency (η_v)

$$\eta_v = \frac{m_a / \rho_a}{V_{disp} \, N/2}$$

ρ_a - inlet density

⑤ Indicated power

$$ip = \frac{P_{im} LANk}{60 \times 1000}$$

⑥ Indicated mean effective pressure

$$P_{im} = \frac{60000 \times ip}{LANk}$$

⑦ Brake mean effective pressure

where,

L = length of the stroke (m)

A = area of the piston (m^2)

N = speed in rpm

n = Number of power strokes

N for 2 stroke & N/2 for 4 stroke.

K = No. of cylinders

(8) Mean piston speed ($\bar{S}_p$)

$$\bar{S}_p = 2LN$$

(9) Specific power output

$$P_s = \frac{bp}{A}$$

(10) Swept volume (V_s)

$$V_s = A \times L = \frac{\pi}{4} d^2 L$$

(11) Cubic capacity = $V_s \times K$

(12) compression ratio (r)

$$r = \frac{V_T}{V_c} = \frac{V_c + V_s}{V_c}$$

$$= 1 + \frac{V_s}{V_c}$$

Design consideration for combustion :

A. Combustion chamber design for SI engines

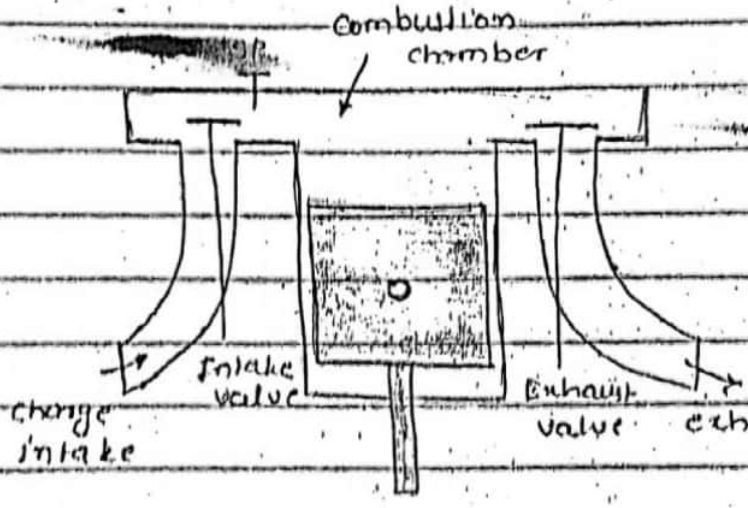
- Developing high power output, high thermal efficiency, smooth running of engines and main obj. minimum ON requirement of fuel are main objectives.
- Length of flame travel from SP to the farthest point in the combustion chamber be kept to minimum to avoid detonation. Central location of spark plug & spherical shape of combustion chamber to reduce length of flame travel.
- Higher volume to surface ratio to minimize heat losses (hemispherical shape provides min S/V ratio)
- Large inlet & exhaust valve area with adequate clearance around valve heads (Reduction in pressure drop & increase in volumetric efficiency.
- Exhaust values not to be located near end gas location of combustion chamber to reduce detonation as these are hottest spots in combustion chamber.
- Exhaust valve region being hottest in combustion chamber to be cooled to reduce detonation.
- ON of fuel requirement increases with bore at same piston speed when other factors remaining same. Combustion time & cylinder inner surface area also increases with bore

- Thickness of cylinder walls to be uniform to avoid non-uniform expansion.

Types of combustion chambers

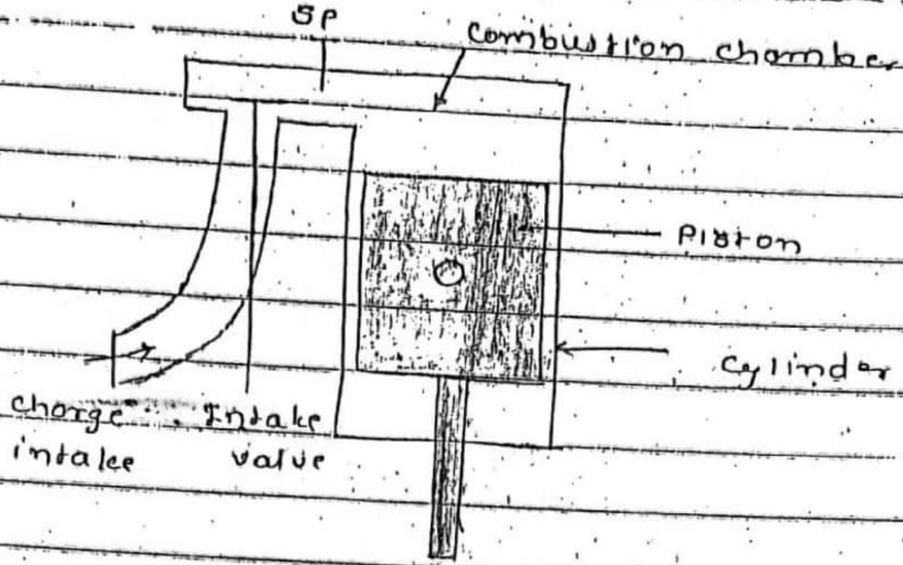
1. Side valve combustion chambers
→ Both types of valves (inlet & exhaust) fitted in engine block.
2. F-head valve combustion chamber,
→ one valve fitted in engine head & the other in engine block.
3. I-head / overhead valve combustion chamber
→ Both valves fitted in cylinder head.

(1) Side valve combustion chambers
a). Side valves T-head combustion chamber



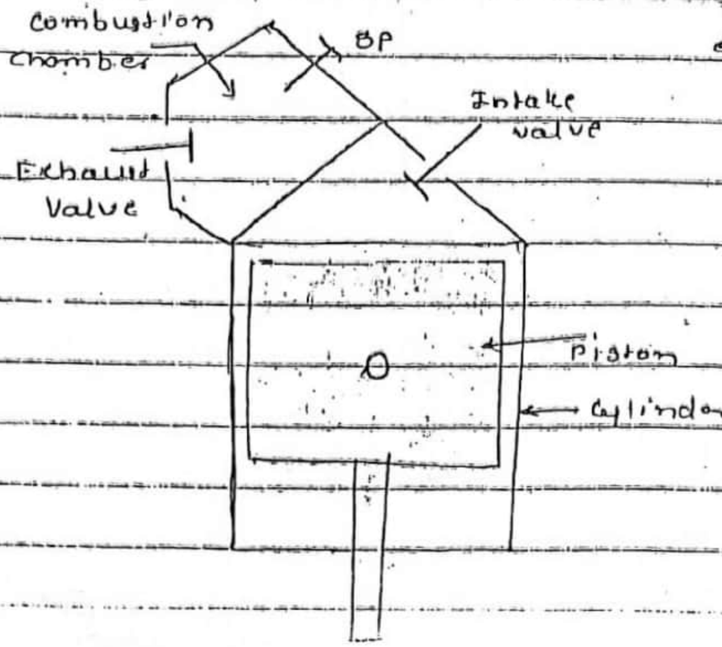
- valves fitted in the engine block
- used in ford engines earlier
- Two camshafts are used
- prone to detonation due to combustion chamber being very long.

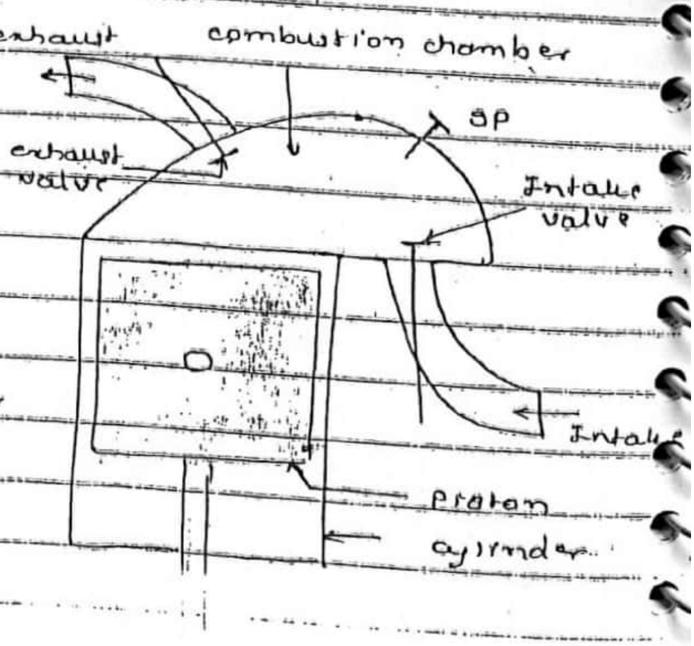
b) Side valves L-head combustion chamber



- Valves fitted in engine block
- One cam shaft is used
- Valves placed side by side
- Easy maintenance
- Air has to take two right turns
- Lack of turbulence reducing volumetric efficiency.
- Poorer compared to overhead valves design.

(2) F-head valve combustion chamber

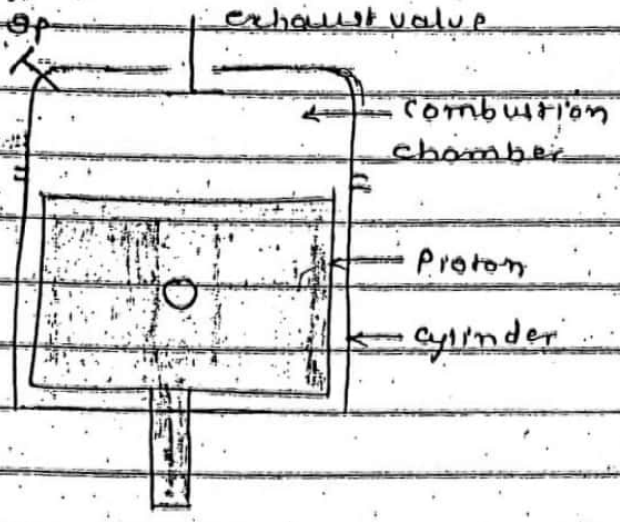




- Exhaust valve is in engine head
- Two camshafts are used
- Intake valve is in engine block

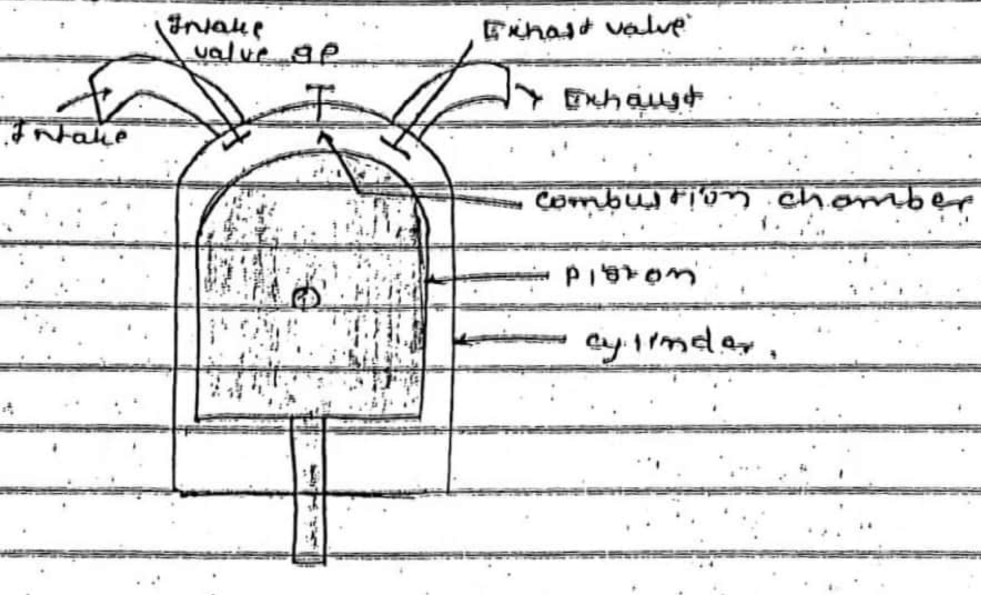
(3) I-head / overhead valve combustion chambers

a) overhead bath Tub combustion chamber.



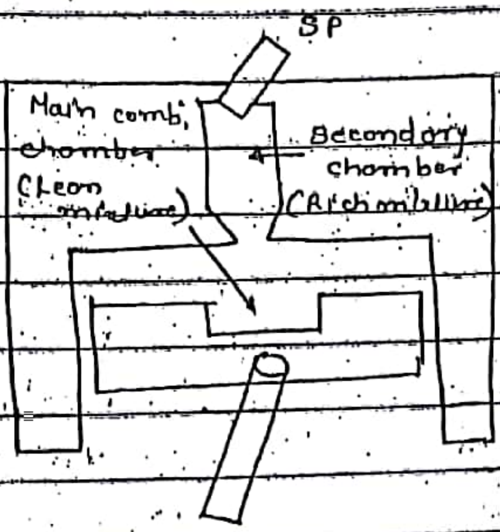
- Both valves are mounted vertically overhead
- one camshaft is required
- High turbulence
- High flame speed

b) I-head / overhead valve combustion chamber.



- Hemispherical shape
- SP located centrally
- Valves slanted on sides
- Two camshafts
- Compact & efficient
- High volumetric efficiency

(4) Divided combustion chamber :

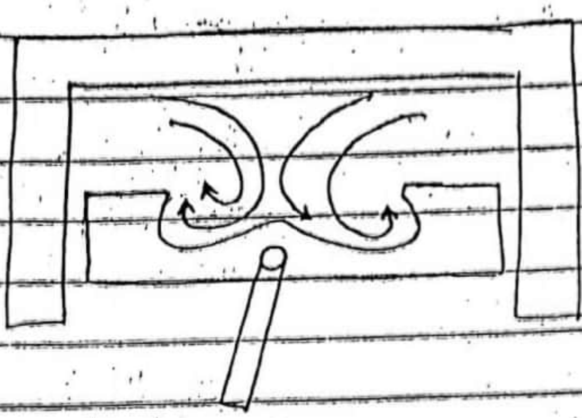


- About 80% of clearance volume in main combustion chamber in/above piston & 20% in secondary comb. chamber connected through orifice
- Combustion starts in secondary combustion chamber & flame then passes through the orifice, where it ignites the main combustion chamber.
- Intake swirl is not important in main chamber of this type. Hence intake can be designed for greater volumetric efficiency
- Desirable to have very high swirl in secondary combustion chamber & orifice does ~~not~~ this job. Secondary combustion chamber is called swirl chamber.
- Due to combustion pressure rises in secondary chamber & flaming gas expand back through the orifice as torch ignition for main chamber
- Usually [illegible]
- [illegible]

- Intake system is designed to supply a rich mixture to secondary chamber & lean mixture to main chamber.
- Rich mixture with very high swirl in secondary chamber ignites readily & combust very quickly.
- Ignition torch now coming from orifice ignites the lean mixture in main chamber, as a SP alone would not be able to do so. This gives a very good fuel economy.

C

⑤ Modern fast burn combustion chamber.

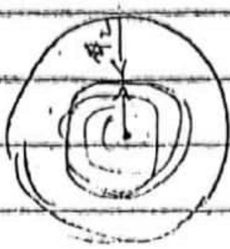


C

- Combustion chamber for modern high speed SI engines must be able to burn the Air fuel mixture very rapidly, must provide smooth power stroke, low specific fuel consumption & maximum thermal efficiency.
- As the piston approaches TDC, AF mixture is compressed towards centreline of the cylinder.
- Conservation of momentum causes a larger increase in swirl as average mass radius is decreased.
- The inward compression also causes a large squish velocity in radial direction.

towards the centreline.

- Both these motions greatly increase flame front speed & decrease combustion time.
- There is also a reverse outward squish that further increases the spread of flame front.
- This occurs early in the power stroke, when piston starts moving away from TDC. These motions increase flame velocity by a factor of about 10
- For such combustion chambers, intake system is designed to provide high turbulence & inlet swirl.
- Spark plug is placed near the centreline of the cylinder, so the flame must travel only about one-fourth of bore dia, before the most of Air fuel is consumed
- Some engines use two spark plugs / cylinder to flame fronts & decrease the time by almost half.
- Both the sp's can be fired simultaneously or sequentially.



3. Combustion chamber design for CI engine

For efficient combustion, it is necessary that fuel is atomized, vaporized & properly mixed with air in a very short period (as the fuel is injected just few degrees before TDC during compression stroke)

Therefore, mixing of fuel & air is of great importance in CI engines to obtain desired power output, efficiency & short delay period for smooth running of engine. Hence main objectives are

- Fine atomization of fuel
- Proper mixing of fuel & air
- Generating requisite turbulence
- Complete burning of fuel to obtain max. efficiency
- Low S/V ratio to reduce heat losses for higher efficiency
- Short delay period for smooth operation of the engine

Classification of combustion chambers

1) Non-turbulent / open / Direct (DI) combustion chambers.

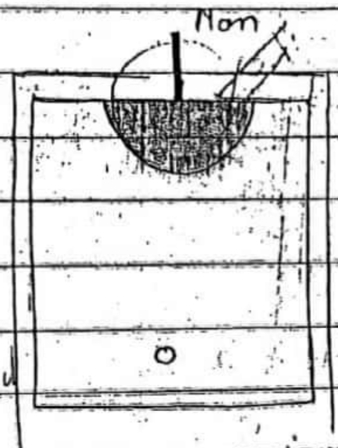
~~whole combustio~~

2) Turbulent / Indirect (IDI) combustion chambers
   a) Swirl combustion chambers
   b) Pre-combustion chambers
   c) Air-cell combustion chambers

3) MAN combustion chambers

① Direct / open combustion chambers.

- Whole combustion chamber as one cavity ; same pressure throughout
- Utilize induction swirl method
- Direct fuel injection in to (main) combustion chamber

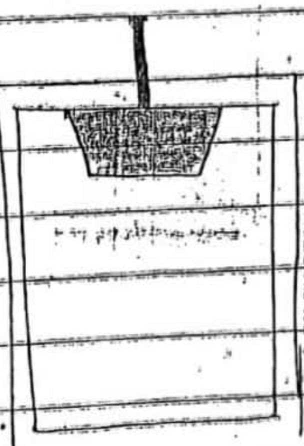


- Cavity is quite small
- Adopted for large engines running at low speeds.
- Cavity dia large
- Squish negligible

Hemispherical

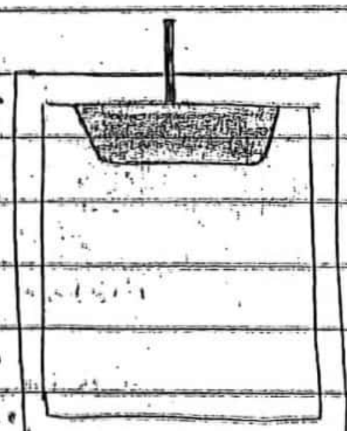
depth ... ration ... be ... to get desired squish

Shallow depth



- modification of cyl. chamber in the form of truncated cone with base angle 30°.
- Swirl produced by masking the valve by 180° of circumference
- Squish can be changed by varying the depth.

Truncated cone



- Squish can be changed by vary... depth

Rectangular

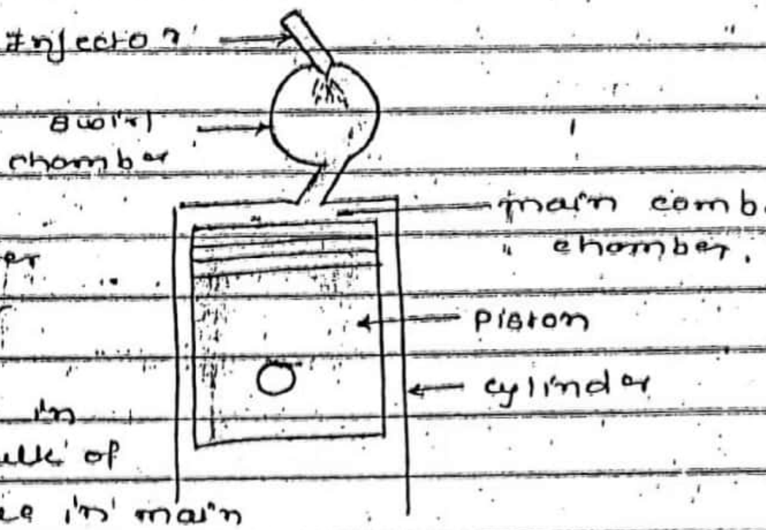
② Turbulent / Indirect (IDI) combustion chambers

- Combustion chamber divided in to two or more portions hence pressure difference may exist

...

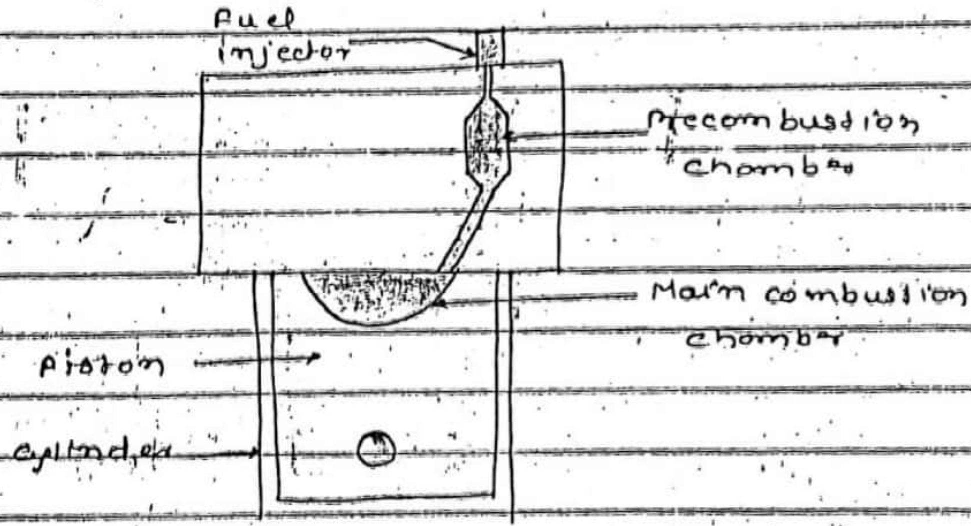
a) Swirl combustion chambers

- Employ compression swirl method
- e.g. Recordo swirl comb. chamber



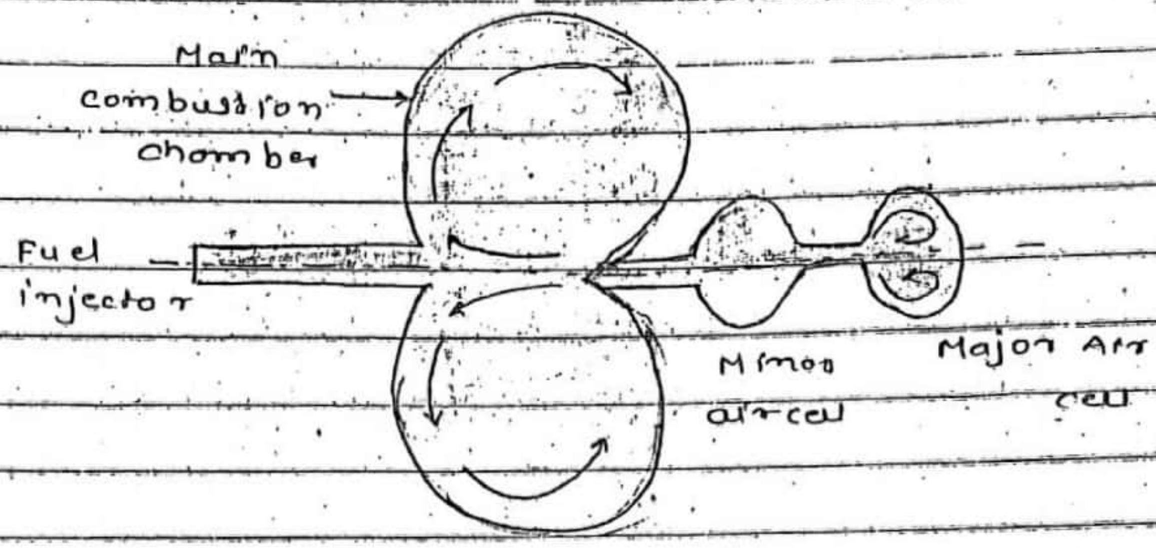
- Throat connect the main chamber to swirl chamber tangentially.
- Due to this during compression air enter into swirl chamber with high swirl.
- Combustion starts in swirl chamber & bulk of combustion takes place in main comb. chamber.

b) Pre-combustion chamber



- Employ combustion induced swirl
- Pre-combustion chamber occupies 20-30% of total combustion space (of V_c)
- Combustion starts in pre-combustion chamber, however bulk of combustion takes place in main combustion chamber
- Peak pressure around 40 bar & injection pressure 150 bar
- Popular in German design & employ pintle type nozzles.

c) Air cell combustion chamber



- Employ combustion induced swirl, however more of turbulence.
- Air cell occupies 10-15% of total combustion space (of V_c)
- combustion starts in air cell; however bulk of combustion takes place in main combustion chamber
- Peak pressure around 50 bar & injection pressure 200 bar.
- Popular in American design

(3) Man combustion chamber

- Combustion chamber of hemispherical shape & in piston
- fuel injector inclined & injects fuel directly on the wall of combustion chamber for quick vaporization
- German design

8 Petrol Engine Fuel Supply Systems

1. FUEL SUPPLY SYSTEMS

The basic fuel supply system in an automobile with petrol engine consists of a fuel tank, fuel lines, fuel pump, fuel filter, air cleaner, carburettor, inlet manifold and supply & return pipelines.

Following are the types of systems which have been used for the supply of fuel from the fuel tank to the engine cylinder:—

(1) Gravity system
(2) Pressure system
(3) Vacuum system
(4) Pump system
(5) Fuel injection system.

Out of these the first four systems make use of the carburettor while in the fuel injection system the carburettor has been dispensed with altogether. The gravity system is confined to two wheelers while the pressure and the vacuum systems are almost obsolete now and the pump systems is being used widely on automobiles. Due to certain advantages, the use of fuel injection system is rapidly increasing in modern vehicles.

1. Gravity System

In this fuel tank is mounted at the highest position from where the fuel drops into the carburettor float chamber by gravity. The system is very simple and cheap but the rigidity of placing the fuel tank necessarily over the carburettor is a disadvantage.

2. Pressure System

In the pressure system, a hermetically sealed fuel tank is used. The pressure is created in the tank by means of engine exhaust or a separate air pump. For starting, the pump is primed by hand. It is under the pressure thus produced that the fuel flows to the float chamber of the carburettor. There are chances of pressure leak but the advantage lies in the fact that the fuel tank can be placed at any suitable location.

3. Vacuum System

This system is based upon the simple fact that the engine suction can be used for sucking fuel from the main tank to the auxiliary fuel tank from where it flows by gravity to the carburettor float chamber.

4. Pump System

In this system, a steel pipe carries petrol to the fuel pump which pumps it into the float chamber of the carburettor through a flexible pipe. If the fuel pump is mechanical, it has to be driven from the engine camshaft and hence placed on the engine itself. However, electrically operated fuel pump can be placed anywhere, the rear location (away from the engine) reducing the tendency of forming vapour lock. This system is used most commonly in the present day cars.

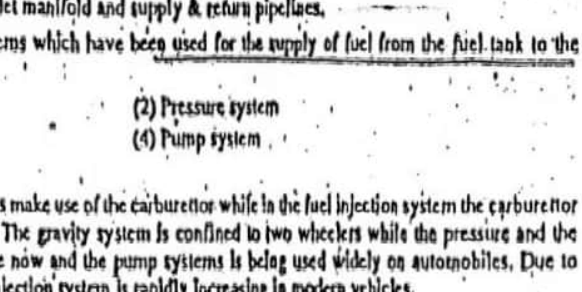


Fig. 8.1. Pump system of fuel supply.

Mechanical fuel pump Testing —

There are three main tests which are performed to judge the performance of a fuel pump.

There are :—

* Mechanical Fuel pump testing

- Mechanical fuel pump is a device which draws the fuel from the tank, through the fuel lines and fuel filter, to the engine's carburetor or injectors
- Two types of test carried out while testing mechanical fuel pump

1] Pressure or Volume Test

2] Vacuum Test

*1] Pressure or Volume Test

i) Remove the air cleaner, then disconnect the fuel line at the carburetor or injectors

ii) connect a pressure gauge hose to the fuel line or use 'T-fitting' while connecting gauge

iii) Attach a tachometer to the engine

iv) start the engine and operate it at specified speed

v) compare the gauge readings with those in the manual

vi) Turn the engine off and watch the gauge.

vii) Disconnect the pressure gauge from the fuel line and reconnect the fuel line to the carburetor injector input

viii) If pump fails the pressure or volume test it generally require replacement

* 2] Vacuum Test

i) Disconnect the low-pressure fuel inlet fitting at the mechanical fuel pump

ii) Install a T-fitting between the disconnected inlet fitting and mechanical fuel pump inlet

iii) connect the vacuum gauge to the T-fitting.

iv) Start the engine and hold the engine speed at 1500 rpm for 30 seconds. Vacuum should not exceed 3.75 in Hg

v) If vacuum exceeds 3.75 in Hg, check the fuel inlet tube for a restriction.

vi) Bleed the air from fuel system

• Observations while conducting tests

i) If we see the fuel squirt into the carburettor means the pump is working and if we do not see squirting the fuel pump has probably failed.

ii) If we see the strong steady spurts of fuel through the fuel line means pump is working and

If no fuel or weak stream means a bad pump, plugged fuel filter, fuel line blockage or no fuel in the tank

iii) If there is no pressure or pressure is less than the speci--fication then the pump is bad and need to be replaced.

* Cylinder power balance

i) Cylinder power balance test measures the amount of the power that a particular cylinder contributes to the total power output of the engine.

ii) cylinder power balance test uses the cylinders effect on the engines speed to determine this power

iii) The cylinder power balance test identifies the less produ--ctive cylinders

• cylinder power balance test can be connected by two different ways

a) Without an engine analyzer

b) With an engine analyzer

a) Cylinder power balance test without an engine analyzer

i) The tachometer is needed to measure the engine rpm.

ii) To conduct test spark plug wire from the spark plug has to be disconnected and grounded

iii) The change in the engine speed with cylinder disconnected is the amount of drop caused by that cylinder

iv) The test continued by disconnecting wire to each cylinder one at a time and record the change

v) The cylinder that causes the least change in engine speed when disconnected are those that are producing the least amount of power and if there is no change in speed the cylinder producing very little or no power,

b) Cylinder power balance test with analyzer

i) First connect analyzer according to manufactures procedure

ii) Disconnect and plug the vacuum line to EGR valve if fitted with engine.

iii) Now start the engine and let it run until it is at normal operating temp.

iv) When engine is warm, set the engine speed to its fast idle speed using fast idle cam

v) With engine running at its 1st idle speed short out the 1st cylinder and note the drop in engine speed.

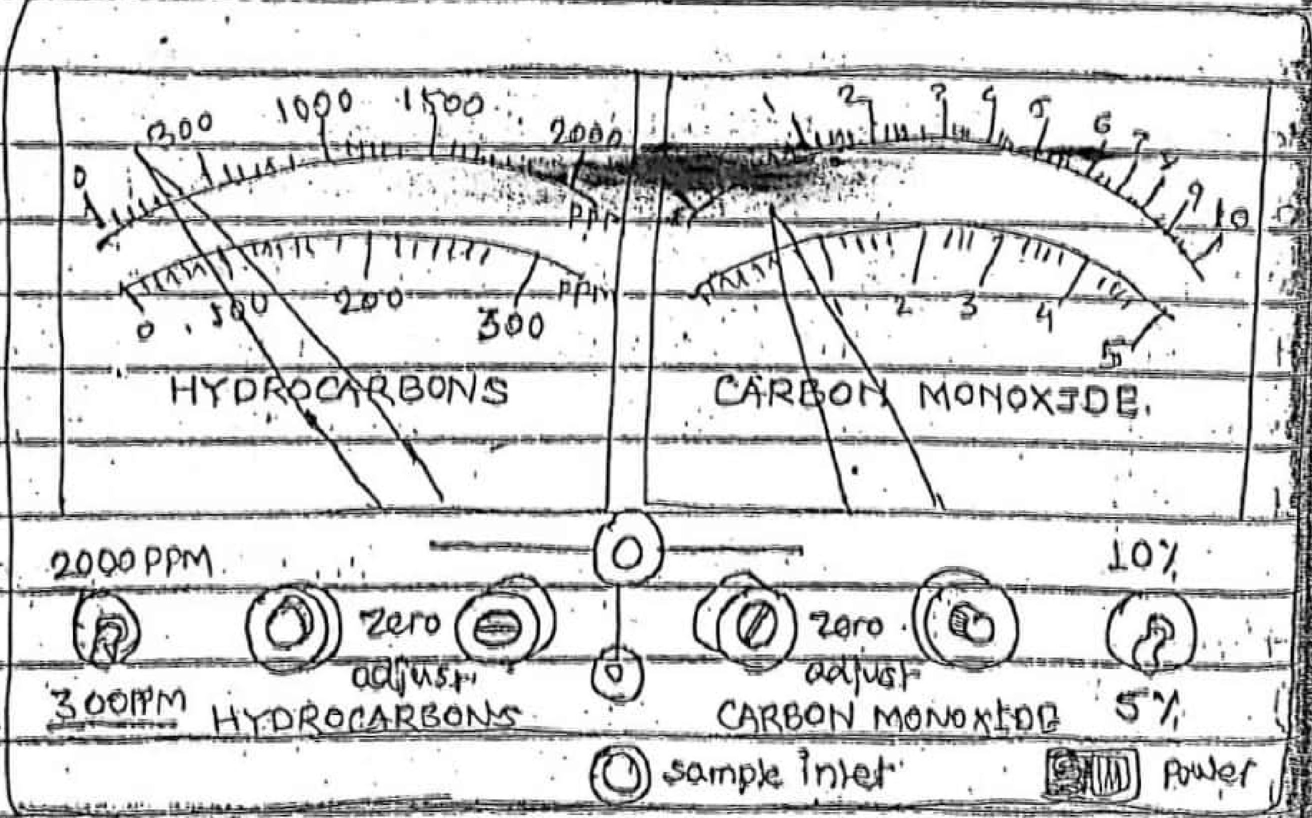
vi) Engine now running on all cylinders again.

vii) After short period short the next cylinder and record rpm drop and continue the test

viii) If all cylinders receive the same amount of fuel, air and heat the rpm drop of each should be within 30 rpm of each other

ix) If diff. betn cylinder is greater than 30 rpm, the engine power is out of balance.

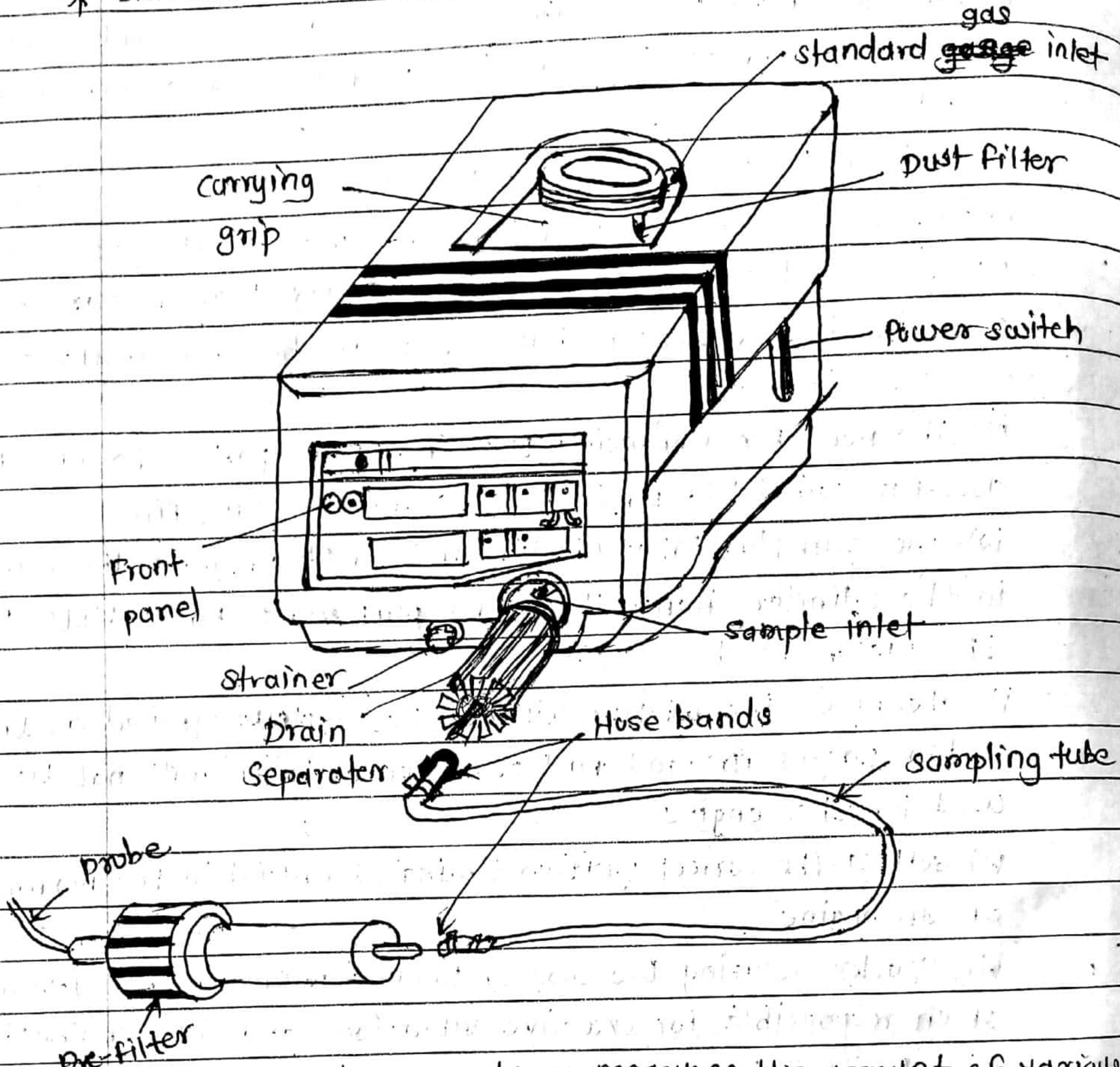
Exhaust gas CO & HC Analyzer. :-



- The exhaust gas analyzer measures the amount of various gases in the exhaust. There are two main types.

1. Two gas Analyzer measures HC & CO
2. Four gas Analyzer measures HC, CO, O_2 and CO_2

* Exhaust Gas CO and HC analyser



i) The exhaust gas analyser measures the amount of various gases in the exhaust

There are two main types

1) Two gas analyser that measures HC and CO

2) Four gas analyser that measures HC, CO, O_2 and CO_2

ii) The purpose of making these measurements is to help determine the condition of the engine, ignition system, fuel system and emission controls

iii) On a car with catalytic converter, tail pipe reading made with a two gas analyser

iv) Normal action of catalyst reduces HC and CO nearly to zero

v) Four gas analyzer provide more complete analysis of tailpipe exhaust gas

vi) carbon dioxide and oxygen in exhaust gas from cylinder pass unchanged through the catalytic converter.

vii) Measuring these gases at the tail pipe gives a more complete picture of the air-fuel mixture entering the cylinder and the combustion process

viii) To use exhaust gas-analyzer, block off the air flow from the air injection or air aspirator system. This prevents additional air from affecting the readings.

ix) Inserts the exhaust gas pickup and probe into tailpipe of car.

x) The probe draws out some of exhaust gas and carries it through analyzer

xi) Meters, a display, or a printout show how much of each gas is in sample of exhaust gas.

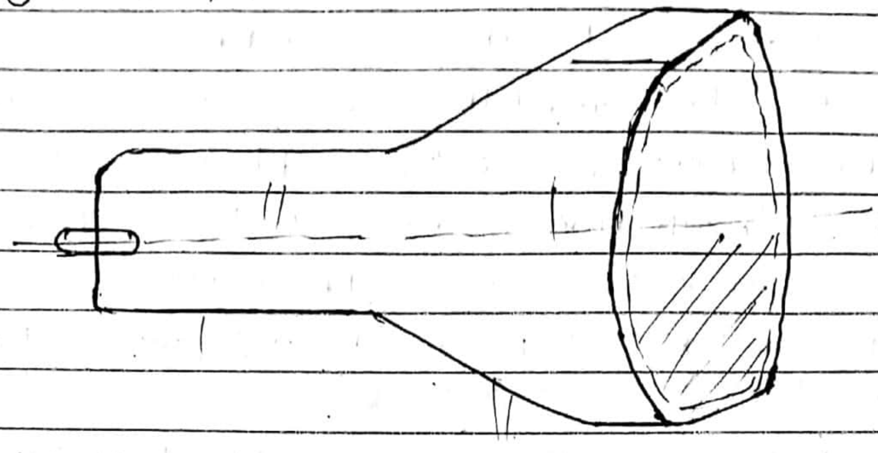
xii) While testing exhaust emission, follow tester manufactures operating instructions

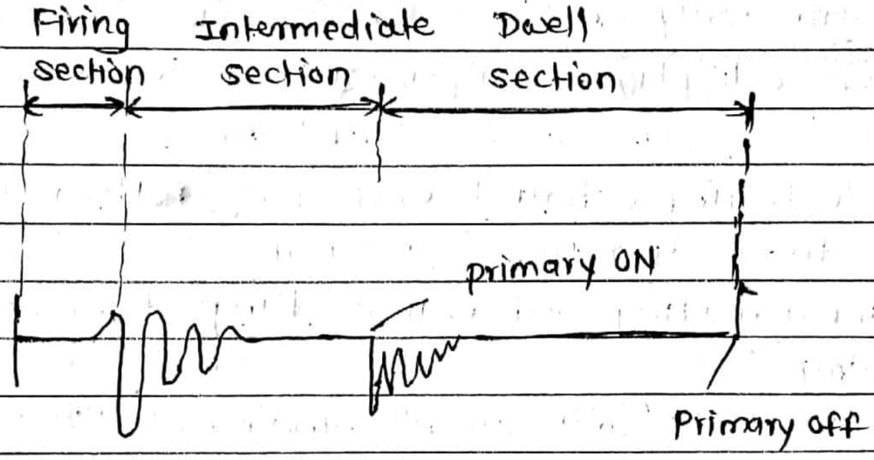
xiii) Take a reading with engine idling at normal operating temp

Repeat the test with engine running at 1500 rpm and 2500 rpm.

* Oscilloscope Engine Analyzers

- Oscilloscope is valuable tool for diagnostic of engine ignition system.





* Oscilloscope engine analyser *

i) The oscilloscope is like a television set where the viewing screen is the front side of cathode Ray Tube (CRT)

ii) " Hook-ups" or leads from the oscilloscope are conn--ected to the engine ignition system such as the ignition wires and even battery cables.

iii) The oscilloscope can then read the inputs from the primary circuit, a secondary circuit and reference circuit which is used to locate sequence (proper firing order and the ground circuit

iv) The oscilloscope shows different pattern on the screen such as, a wave pattern, a parade pattern, a stacked pattern and a Superimposed pattern

v) All these different types of patterns tell a story one way or another about what is happening with the ignition

* Distributor Dwell Angle

i) The dwellmeter electrically measures how long the contact point remains closed during each ignition cycle of a contact-point ignition system

ii) The average for all cylinder is then displayed in degrees of distributor cam rotation

iii) The technician can also use dwellmeter to set the contact point gap and to check for unwanted dwell variation as engine speed increases

iv) Excessive variation indicates mechanical trouble in the distributor

v) In electronic ignition system, the ECM controls the dwell it isn't adjustable.

vi) Dwellmeter is used to check the duty cycle of the mixture control solenoid in a feedback carburetor

vii) A dwell-tachometer is a single meter that serve as both dwellmeter and a tachometer. This is possible because both metres have two leads as require same connections

viii) Pushing a button or turning a knob on the metre switch readings from rpm to dwell

* Adjusting dwell angle

1. Connect tester
connect green clip to terminal 1 on coil and back clip to a metal part.

2. Calibrate the tester
set test selection switch to "A". Turn knob of calibrating switch until needle is exactly on the end mark of scale.

3. Measure dwell angle
- start engine and run it at about 1000 rpm. Read off dwell angle on lower scale.
- Then increase engine speed to about 2000 rpm

specified dwell angle 44-50° wear limit 42-58°

4. Adjust dwell angle
- Take distributor cap and rotor arm off and loosen screw
- With ignition switched on and starter turning the engine over, alter the contact gap until correct angle can be read on the tester
- Tighten contact securing screw and check again to see that the angle has not changed as screw was being tightened
- Install rotor arm and distributor cap and check dwell angle again